What is claimed is:

1. An apparatus for reducing drag over an aircraft wing assembly in operational attack situations, the aircraft wing assembly including a wing and an engine nacelle mounted to the wing, the apparatus comprising:

a nacelle chine mounted on an outboard side of an engine nacelle, the nacelle chine being configured to reduce drag by redirecting at least a portion of fluid striking a forward end of the aircraft wing assembly such that a vortex is formed over the forward end of the aircraft wing assembly; and

a mounting base configured to be secured to an outer surface of the engine nacelle at a mounting position along an outer surface of the engine nacelle along a line substantially parallel with an axis of an engine mounted in the engine nacelle.

2. The apparatus of Claim 1, wherein the apparatus is disposed on each of a plurality of engine nacelles on an aircraft having a plurality of engines.

3. The apparatus of Claim 1, wherein size and placement of the nacelle chine are optimized according to an engine and wing combination for reducing drag according to one of modeling and empirical testing.

4. The apparatus of Claim 3, wherein the size and the placement of the nacelle chine are determined to reduce drag for a wing equipped with a leading edge high lift device including one of a flat panel Krueger flap, a variable camber Krueger flap, or a slat.

5. The apparatus of Claim 4, wherein the leading edge high lift device does not extend along a forward edge of the wing in a position over a location where the engine is mounted on the wing.

6. An apparatus for reducing drag generated around a wing of an aircraft in an area where an engine is mounted when the aircraft is in operational angle of attack situations, the apparatus comprising:

a mounting base configured to be secured to an outer surface of an engine nacelle at a mounting position along an outer surface of the engine nacelle and along a line parallel with an axis of an engine, the mounting position being made according to a placement configuration specific to an engine and wing combination for reducing drag; and



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a chine extending in a substantially perpendicular and planar direction from the mounting base and shaped to create an outboard wake vortex in fluid striking a forward surface of the engine nacelle and passing over an outboard surface of the engine nacelle and a wing to which the engine nacelle is attached, the chine having chine parameters including a length along the line substantially parallel with the axis of the engine mounted in the engine nacelle, an outer edge shape at an distal edge away from the mounting base, and a radial length measured from the mounting base to the outer edge according to the placement configuration specific to the engine and wing combination for reducing drag.

7. The apparatus of Claim 6, wherein the apparatus employs a placement configuration specific to the engine and wing combination including an outboard placement on the outboard surface of the engine at a location including a radial position between zero degrees and ninety degrees clockwise from a top of the engine measured around the axis of the engine viewing the engine from a front side.

8. The apparatus of Claim 7, wherein the chine parameters and the placement configuration are optimized according to the engine and wing combination for reducing drag according to one of modeling and testing.

9. The apparatus of Claim 6, wherein the chine parameters and the placement configuration are determined to reduce drag for a wing equipped with a leading edge high lift device including one of a flat panel Krueger flap, a variable camber Krueger flap, or a slat.

10. The apparatus of Claim 9, wherein the leading edge high lift device does not extend along a forward edge of the wing in a position over a location where the engine is mounted on the wing.

11. The apparatus of Claim 6, wherein the apparatus is disposed on each of a plurality of engine nacelles on an aircraft having a plurality of engines.

12. A wing assembly for reducing drag in operational angle of attack situations, the wing assembly comprising:

a wing;

an engine nacelle mounted to the wing;



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a nacelle chine mounted on an outboard side of the engine nacelle, the nacelle chine being configured to reduce drag by redirecting at least a portion of fluid striking a forward end of the aircraft wing assembly such that a vortex is formed over the forward end of the aircraft wing assembly; and

a mounting base configured to be secured to an outer surface of the engine nacelle at a mounting position along an outer surface of the engine nacelle along a line substantially parallel with an axis of an engine mounted in the engine nacelle.

13. The wing assembly of Claim 12, wherein the wing assembly includes a plurality of engine nacelles, each of the engine nacelles being equipped with the nacelle chine and the mounting base.

14. The wing assembly of Claim 12, wherein size and placement of the nacelle chine are optimized according to the engine and wing combination for reducing drag according to one of modeling and empirical testing.

15. The wing assembly of Claim 14, wherein the size and the placement of the nacelle chine are determined to reduce drag for a wing equipped with a leading edge high lift device including one of a flat panel Krueger flap, a variable camber Krueger flap, or a slat.

16. The wing assembly of Claim 15, wherein the leading edge high lift device does not extend along a forward edge of the wing in a position over a location where the engine is mounted on the wing.

17. A wing assembly for reducing drag in operational angle of attack situations, the wing assembly comprising:

a wing;

an engine nacelle mounted to the wing;

a mounting base configured to be secured to an outer surface of an engine nacelle at a mounting position along an outer surface of the engine nacelle and along a line parallel with an axis of an engine, the mounting position being made according to a placement configuration specific to an engine and wing combination for reducing drag; and

a chine extending in a substantially perpendicular and planar direction from the mounting base and shaped to create an outboard wake vortex in fluid striking a forward surface of the engine nacelle and passing over an outboard surface







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of the engine nacelle and a wing to which the engine nacelle is attached, the chine having chine parameters including a length along the line substantially parallel with the axis of the engine mounted in the engine nacelle, an outer edge shape at an distal edge away from the mounting base, and a radial length measured from the mounting base to the outer edge according to the placement configuration specific to the engine and wing combination for reducing drag.

18. The wing assembly of Claim 17, wherein the apparatus employs a placement configuration specific to the engine and wing combination including an outboard placement on the outboard surface of the engine at a location including a radial position between zero degrees and ninety degrees clockwise from a top of the engine measured around the axis of the engine viewing the engine from a front side.

19. The wing assembly of Claim 18, wherein the chine parameters and the placement configuration are optimized according to the engine and wing combination for reducing drag according to one of modeling and testing.

20. The wing assembly of Claim 19, wherein the chine parameters and the placement configuration are determined to reduce drag for a wing equipped with a leading edge high lift device including one of a flat panel Krueger flap, a variable camber Krueger flap, or a slat.

21. The wing assembly of Claim 20, wherein the leading edge high lift device does not extend along a forward edge of the wing in a position over a location where the engine is mounted on the wing.

22. The wing assembly of Claim 17, wherein the wing assembly includes a plurality of engine nacelles, each of the engine nacelles being equipped with the nacelle chine and the mounting base.

23. An aircraft for reducing drag in operational angle of attack situations, the aircraft comprising:

a fuselage;

a wing mounted to the fuselage;

an engine nacelle mounted to the wing;

a nacelle chine mounted on an outboard side of the engine nacelle, the nacelle chine being configured to reduce drag by redirecting at least a portion of fluid



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striking a forward end of the aircraft wing assembly such that a vortex is formed over the forward end of the aircraft wing assembly; and

a mounting base configured to be secured to an outer surface of the engine nacelle at a mounting position along an outer surface of the engine nacelle along a line substantially parallel with an axis of an engine mounted in the engine nacelle.

24. The aircraft of Claim 23, wherein the wing assembly includes a plurality of engine nacelles, each of the engine nacelles being equipped with the nacelle chine and the mounting base.

25. The aircraft of Claim 23, wherein size and placement of the nacelle chine are optimized according to the engine and wing combination for reducing drag according to one of modeling and empirical testing.

26. The aircraft of Claim 25, wherein the size and placement of the nacelle chine are determined to reduce drag for a wing equipped with a leading edge high lift device including one of a flat panel Krueger flap, a variable camber Krueger flap, or a slat.

27. The aircraft of Claim 26, wherein the leading edge high lift device does not extend along a forward edge of the wing in a position over a location where the engine is mounted on the wing.

28. An aircraft for reducing drag in operational angle of attack situations, the wing assembly comprising:

a wing;

an engine nacelle mounted to the wing;

a mounting base configured to be secured to an outer surface of an engine nacelle at a mounting position along an outer surface of the engine nacelle and along a line parallel with an axis of an engine, the mounting position being made according to a placement configuration specific to an engine and wing combination for reducing drag; and

a chine extending in a substantially perpendicular and planar direction from the mounting base and shaped to create an outboard wake vortex in fluid striking a forward surface of the engine nacelle and passing over an outboard surface of the engine nacelle and a wing to which the engine nacelle is attached, the chine having chine parameters including a length along the line substantially





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parallel with the axis of the engine mounted in the engine nacelle, an outer edge shape at an distal edge away from the mounting base, and a radial length measured from the mounting base to the outer edge according to the placement configuration specific to the engine and wing combination for reducing drag.

29. The aircraft of Claim 28, wherein the apparatus employs a placement configuration specific to the engine and wing combination including an outboard placement on the outboard surface of the engine at a location including a radial position between zero degrees and ninety degrees clockwise from a top of the engine measured around the axis of the engine viewing the engine from a front side.

30. The aircraft of Claim 29, wherein the chine parameters and the placement configuration are optimized according to the engine and wing combination for reducing drag according to one of modeling and testing.

31. The aircraft of Claim 30, wherein the chine parameters and the placement configuration are determined to reduce drag for a wing equipped with a leading edge high lift device including one of a flat panel Krueger flap, a variable camber Krueger flap, or a slat.

32. The aircraft of Claim 31, wherein the leading edge high lift device does not extend along a forward edge of the wing in a position over a location where the engine is mounted on the wing.

33. The aircraft of Claim 28, wherein the wing assembly includes a plurality of engine nacelles, each of the engine nacelles being equipped with the nacelle chine and the mounting base.

34. A method for reducing drag over an aircraft wing assembly in operational angle of attack situations, the method comprising:

providing an aircraft wing assembly including a wing and an engine nacelle mounted to the wing;

mounting a nacelle chine on an outboard side of the engine nacelle;

redirecting at least a portion of fluid striking a forward end of the aircraft wing assembly such that a vortex is formed over the forward end of the aircraft assembly.



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35. The method of Claim 34, further comprising providing a plurality of nacelle chines on each of a plurality of engines on an aircraft with a plurality of engines.

36. The method of Claim 34, wherein size and placement of the nacelle chine are optimized according to the engine and wing combination for reducing drag according to one of modeling and empirical testing.

37. The method of Claim 36, wherein the size and the placement of the nacelle chine are determined to reduce drag for a wing equipped with a leading edge high lift device including one of a flat panel Krueger flap, a variable camber Krueger flap, or a slat.

38. The method of Claim 37, wherein the leading edge high lift device does not extend along a forward edge of the wing in a position over a location where the engine is mounted on the wing.

39. A method for reducing drag over an aircraft wing assembly in operational angle of attack situations, the method comprising:

providing an aircraft wing assembly, the aircraft wing assembly including a wing and an engine nacelle mounted to the wing such that fluid striking a forward end of the aircraft wing assembly results in a fluid flow that causes drag;

providing at least one nacelle chine mountable on an engine nacelle, the nacelle chine having a mounting base and a substantially planar member configured such that when mounted on the nacelle the chine extends substantially perpendicularly outwardly from the surface of the engine nacelle; and

sizing and positioning the nacelle chine on the engine nacelle such that the fluid striking the forward end of the aircraft wing is at least partially redirected for generating a vortex over the forward end of the aircraft wing assembly to reduce drag.

40. The method of Claim 39, wherein the sizing and the positioning of the nacelle chine includes choosing a length of the nacelle chine in a dimension substantially parallel with an engine axis of an engine and the nacelle chine is not longer than a length of the engine nacelle.

41. The method of Claim 39, wherein the sizing and the positioning of the nacelle chine includes shaping a distal edge of the nacelle chine opposite the surface of the engine nacelle



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such that the distal edge of the nacelle chine facilitates the generating of the vortex but does not interfere with the wing.

42. The method of Claim 39, wherein the sizing and the positioning of the nacelle chine includes longitudinally positioning the nacelle chine such that a leading edge of the nacelle chine is rearward of a leading end of the engine nacelle and the trailing end of the nacelle chine is forward of a trailing end of the engine nacelle.

43. The method of Claim 39, wherein the sizing and the positioning of the nacelle chine employs a placement configuration specific to the engine and wing combination including an outboard placement on the outboard surface of the engine at a location including a radial position between zero degrees and ninety degrees clockwise from a top of the engine measured around the axis of the engine viewing the engine from a front side.

44. The method of Claim 39, wherein the nacelle chine is disposed on an outboard side of the engine nacelle.

45. The method of Claim 39, wherein a single nacelle chine is installed on an outboard side of the engine nacelle on each of a plurality of engines on an aircraft having a plurality of engines.

46. The method of Claim 39, wherein the sizing and the positioning of the nacelle chine are optimized according to the engine and wing combination for reducing drag according to one of modeling and empirical testing.

47. The method of Claim 39, wherein the chine parameters and the placement configuration are determined to reduce drag for a wing equipped with at least one leading edge high lift device including one of a flat panel Krueger flap, a variable camber Krueger flap, or a slat.

48. The method of Claim 47, wherein the leading edge high lift device does not extend along a forward edge of the wing in a position over a location where the engine is mounted on the wing.



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